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TE-M-458 RETROMOTOR
AND IGNITER
SAFETY AND HANDLING PLAN

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GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

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SAFETY AND HANDLING PLAN

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January 4, 1966

GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland

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Abstract

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The Anchored Interplanetary Monitoring Platform (AIMP) Spacecraft utilizes a 78.63 lb TE-M-458 Retro Motor for Lunar orbit insertion. Due to the potentially hazardous nature of the handling, checkout and integration of the motor into the spacecraft, certain operational precautions and design safety features have been adapted. This document describes the retro motor and igniters and lists the precautions that will be taken during spacecraft buildup at the launch site to reduce the potentially hazardous conditions to safe and acceptable levels.

Authn

CONTENTS

	<u>Page</u>
Abstract	iii
INTRODUCTION	1
TRANSPORTATION	1
MOTOR DESCRIPTION	2
IGNITER DESCRIPTION	8
GENERAL SAFETY AND HANDLING PROCEDURES	8
FIRING CIRCUIT DESCRIPTION	10
ORDNANCE PREPARATIONS AND ASSEMBLY	13
Motor and Igniter (PAA Solid Propellant Area)	
Motor Alignment (NASA/DAC Spin Facility)	
Igniter Installation (Gantry 17A)	
SUMMARY	17

IMP D
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INTRODUCTION

The Anchored Interplanetary Monitoring Platform (AIMP) Spacecraft will be launched during the calendar year 1966 into a transfer trajectory by a thrust-augmented improved Delta Vehicle (DSV-3E). After a 72 to 80 hour transfer trajectory coast period a TE-M-458 retromotor mounted on the spacecraft will be ignited by ground command and will decrease the velocity of the spin stabilized spacecraft, allowing its capture by the lunar gravitational field into an elliptical lunar orbit.

The motor which meets this mission requirement is the TE-M-458 AIMP Solid Propellant Retro Motor manufactured by the Thiokol Chemical Corporation, Elkton, Maryland under contract to the Mechanical Systems Branch (Code 723), Goddard Space Flight Center. For discussion purposes this motor will be termed the retromotor or motor throughout this document.

Due to the potentially hazardous nature of the handling, checkout and integration of the motor into the spacecraft, this document describes the motor and igniter and highlights the operational precautions and design safety features which reduce the potentially hazardous conditions to safe and acceptable levels.

TRANSPORTATION

Two spacecraft (Prototype and Flight Unit) will be shipped to the Eastern Test Range by aircraft. Two TE-M-458 retromotors will be shipped by all cargo air freight for each launch from Thiokol Chemical Company, Elkton, Maryland to Cape Kennedy Air Force Station in accordance with established ICC regulations. The motors are classified by ICC as:

Jet Propulsion Units
Class "B" Explosive
Contained in Steel Containers

The motors and igniters will be shipped in appropriately marked steel containers to:

PAA Supervisor of Solid Propellants
Cape Kennedy Air Force Station, Florida

Mark For: TE-M-458 Retromotors
GSFC AIMP Program
Attn: D. C. Sheppard/E. W. Travis
Hangar AE
Phone UL 3-2524

On arrival at Cape Kennedy Air Force Station, the motors and igniters will be placed in solid propellant storage and will remain in storage (except during X-ray) until the initiation of preparations required prior to installation on the flight spacecraft in the NASA/DAC Area 39 Assembly Facility.

MOTOR DESCRIPTION

The TE-M-458 Retromotor (Solid Propellant) is a spherical design utilizing a modified TE-345 (Titan Vernier) and TE-375 (Syncom) type case and attach ring, a TE-385 (Gemini) and TE-444 (Lincoln Lab) type aft closure and nozzle assembly and twin TE-P-462 Pyrogens.

The motor diameter is 13.562 inches and the length is 21.226 inches overall. The chamber is fabricated from 6AL-4V Titanium. The nozzle is a high pressure molding of a vitreous silica-phenolic material. A high density graphite material (Graph-i-tite GX) is used as the throat material. The insert is pressed into the aft closure and bonded in place using EPON VIII. For internal insulation of the rocket motor, Gen-Guard V44, an asbestos-filled polyisoprene rubber, is used. The insulator contains an integral separation boot to relieve thermally induced strains in the propellant grain. The total weight of the retromotor is 78.63 pounds. Complete motor physical and ballistic characteristics are included in Table I.

Table 1

TE-M-458 MOTOR

1.0 MECHANICAL DATA

Dimensions	(See Figure 1)
Total Weight - Loaded	78.63 lbs
Inert Weight - Fired	9.61 lbs
Propellant Weight	68.30 lbs
Center of Gravity	
Inert Parts - Fired	8.97 inches forward of attach flange
Loaded Assembly	5.35 inches forward of attach flange

Table 1 (Continued)

Dynamic Unbalance	
Inert Parts Before Loading	Less than 1.0 oz. - in ²
Inert Parts After Firing	Less than 5.0 oz. - in ²
Loaded Motor Assembly	Less than 50 oz. - in ²
Thrust Misalignment	See DWG GE IMP (D) 2366
Moment of Inertia	
Loaded Motor	
^I Roll	0.330 Slug-ft ²
^I Pitch (max. about C. G.)	0.370 Slug-ft ²
Fired Motor	
^I Roll	0.041 Slug-ft ²
^I Pitch (max. about C. G.)	0.084 Slug-ft ²
Propellant Density	0.062 lbm/in ³
Propellant Composition	Combination of ammonium perchlorate and aluminum powder with a poly- urethane binder
Case Liner	Thiokol TL-G-301
Case Insulation	Asbestos-filled polyisoprene rubber
Nozzle Design	
Throat Area (Average)	0.945 in ²
Expansion Ratio (Average)	41.7
Exit Area	39.4 in ²
Half Angle of Nozzle	17.0 degrees
Grain Design	
Type	Spherical, internal burning, eight point star
Outside Diameter	13.45 inch
Length	11.05 inch
Web Thickness	4.187 inch
Volumetric Loading Density	86.0%

2.0 MOTOR PERFORMANCE DATA

2.1	Pressure and Time Parameters (Calculated Nominal)			
	Motor Conditioned Firing Temp.	0° F	+60° F	+120° F
	Max. Chamber Pressure, PSIA	514	550	585
	Average Chamber Pressure, PSIA	468	500	535
	Burn Time, Sec	23.2	21.8	20.4
	Action Time, Sec	24.0	22.4	21.0
	Ignition Delay Time, Sec	0.070	0.060	0.055

Table 1 (Continued)

Ignition Rise Time, Sec	0.030	0.020	0.015
Ignition Time, Sec	0.100	0.080	0.070
2.2 Thrust and Impulse Parameters (Calculated Nominal)			
Motor Conditioned Firing Temp.	0°F	+60°F	+120°F
Maximum Thrust, lbf	855	916	976
Burntime, Average Thrust, lbf	795	850	910
Total Impulse, lbf-Sec	(Classified)		
Propellant Specific Impulse, lbf-Sec/lbm	(Classified)		
3.0 <u>TEMPERATURE DATA</u>			
Expected Case Temperatures	250°F at Burnout (22.4 sec) 400°F at 30 sec up to 780°F max. at 160 sec		
Firing Temperature Limits (Propellant)	0° to +120°F (-18°C to +49°C)		
Pyrogen Firing Temp. Limits	-60°F to +190°F (-52°C to +88°C)		
Storage Temperature Limits	0° to +120°F		
Recommended Storage Temp.	80 ±5°F		
Estimated Storage Life	3 years at 80°F		
4.0 <u>EXPLOSIVE CLASSIFICATION</u>	Category A (Per general range safety plan and GLO safety requirements) ICC Jet Thrust Unit Class B Explosive.		
5.0 <u>IGNITER (TEM-458)</u>			
Igniter Assembly	Thiokol DWG E 17466 (See Figure 2)		
Squib (One-Igniter Assembly)	Thiokol DWG E 16560 (See Figure 3)		
Quantity Per Motor	Two Igniters 180° apart single bridge- wire each		
Squib Specification	Thiokol Spec. SE-225		
Bridgewire Resistance	1.0 \pm .2 ₀ OHM		
Recommended All Fire Current	4 ± .5 amps		
No Fire Current	Meets ETR 1 amp, or 1 watt for 5 minute no fire requirement		
Insulation Resistance	Greater than 100 megohms at 500 VDC (Pin to pin or pin to case)		

Table 1 (Continued)

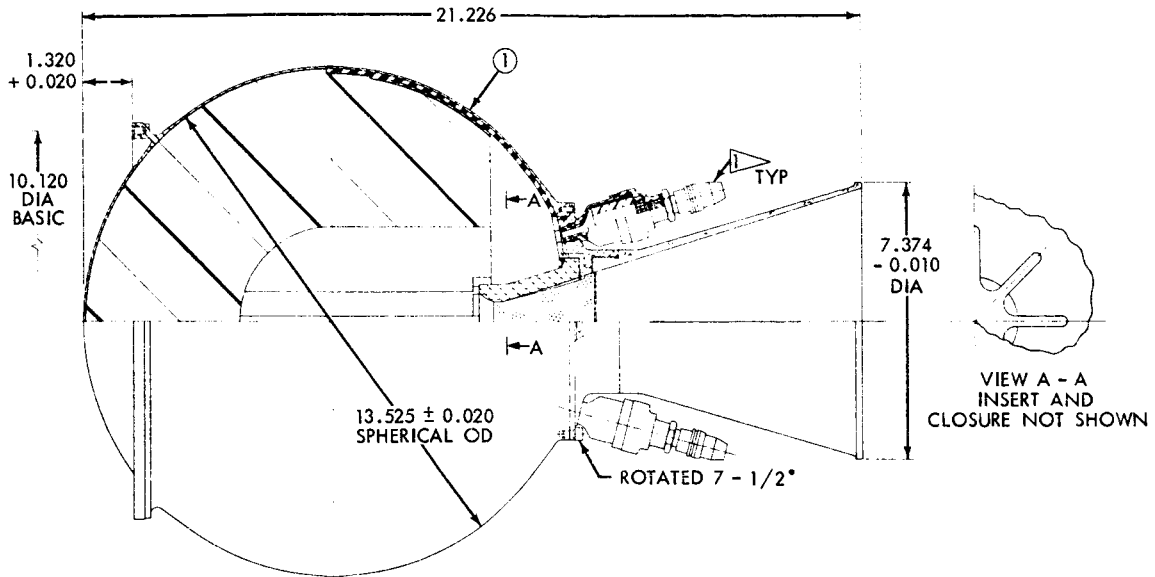


Figure 1 - TE-M-458 Motor

Resistance After Firing	1000 ohms minimum (Pin to pin or pin to case)
Temperature Limits	-65° F to +165° F

6.0 ASSEMBLY AND INTERCHANGEABILITY

The igniter assemblies will be shipped separate from the TEM-458 Motors. Both igniters and igniter squibs in each motor are interchangeable, can be installed or removed at any time. Igniters will be installed in the TEM-458 Motor just prior to fairing installation on the improved Delta Vehicle.

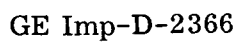


Table 1 (Continued)

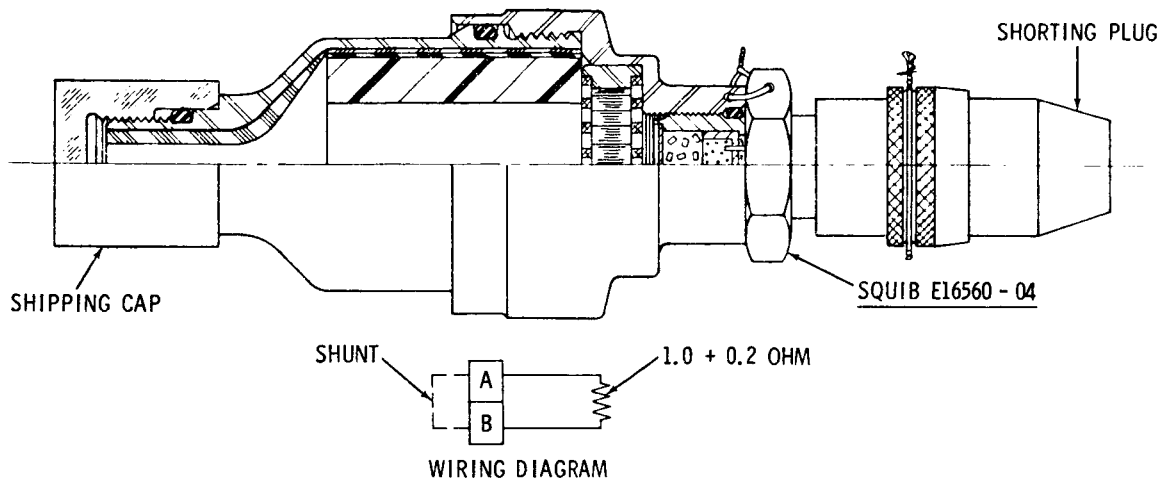


Figure 2 - Igniter Assembly (TE-M-458 Motor)

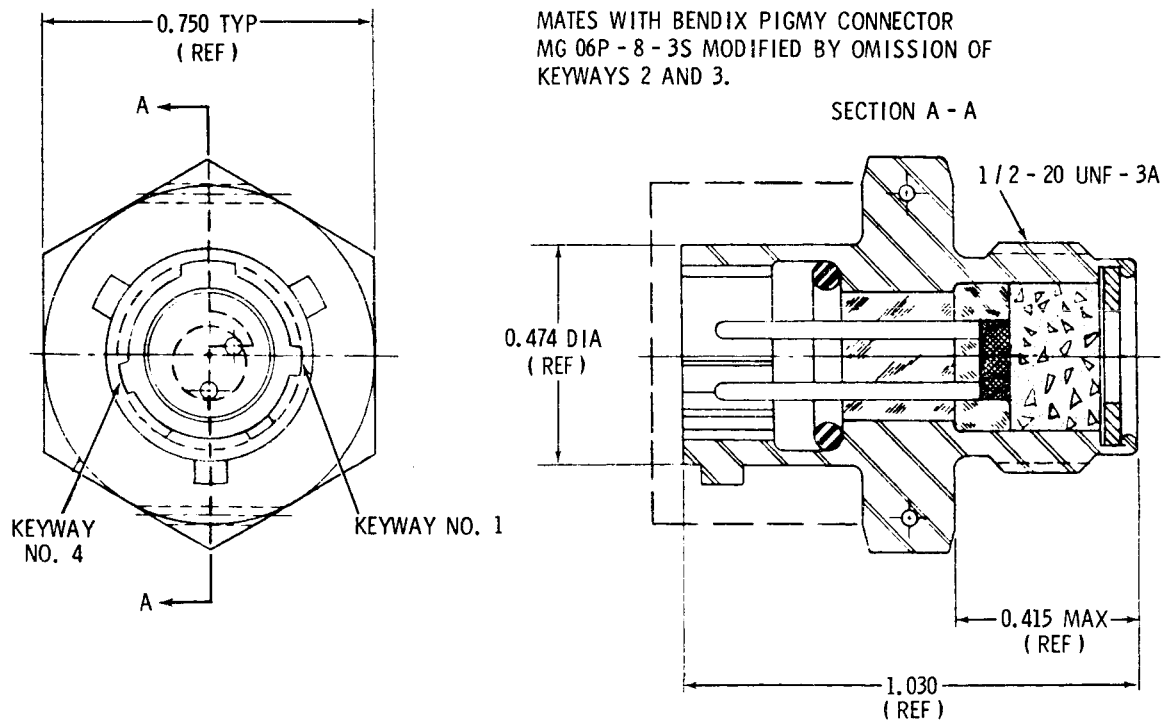


Figure 3 - Squib Igniter TE-M-458

IGNITER DESCRIPTION

The motor is ignited by redundant Pyrogen igniters. The TE-P-462 type Pyrogen consists of a case and head cap made from 302 stainless steel, a cartridge loaded TP-E-8035 propellant grain, a Halex 4497 one amp, 1 watt single bridgewire squib, a boron pellet booster charge, and a silica phenolic nozzle throat section. The Pyrogen is approximately 4-1/2 inches long, weighs 0.41 pounds each, and burns for approximately 0.2 seconds. The Halex 4497 squibs have been satisfactorily subjected to the ETR 1 watt or 1 amp for 5 minute test and the two part electrostatic (ZAP) test consisting of a discharge of a 500 micro-micro farad capacitor at 500 volts and application of 30,000 volts DC across the pin to case mode. See Table 1 for further details.

GENERAL SAFETY AND HANDLING PROCEDURES

The following precautions will be exercised during all operations involving the TE-M-458 motors and TE-P-462 Pyrogen igniters. These instructions are designed primarily to insure maximum safety to personnel but also establish the environmental limits on the motor during storage and insure proper handling of the motor when out of its shipping container.

- A. Permission will be obtained from the responsible supervisor of the PAA Solid Propellants Area and/or the NASA/Douglas Spin Facility prior to beginning any operation. Only authorized personnel will be permitted to handle the rocket motor and/or pyrogen, i. e. , GSFC or Thiokol personnel or personnel under their supervision. The number of personnel present will be held to the minimum required to perform the required operation.
- B. Removal of components from the shipping container, inspection, and assembly or disassembly will be accomplished only in a designated facility in the PAA Solid Propellants Area or in the NASA/Douglas Spin Facility. The rocket motor will be transported only in its shipping container.
- C. The motor shipping container will be grounded at all times during storage. The retromotors are grounded to their container. During transfer of the motor from the container, it will always be electrically grounded. When mounted to the AIMP spacecraft, the retromotor, the retro thermal blanket, the spacecraft and the pyrogen igniters are all electrically tied to each other and to ground.
- D. Personnel handling the motor and/or igniter will be grounded by legstats to the same system that the retromotor and/or igniter is

grounded to eliminate the possibility of static electricity buildup and discharge.

- E. Personnel working on the motor or igniter will wear nonstatic producing, flame retardant coveralls, legstats and static free gloves.
- F. Work areas will be covered with a conductive mat with ground straps attached to the building ground system.
- G. Electrical resistance or continuity checks on the pyrogen igniters will be made with an Alinco Igniter Tester, Model 101-5BFM in the PAA igniter test area. Personnel will be protected from the pyrogen igniter by a steel and concrete barrier during this test.
- H. The live pyrogen igniters will not be installed in the retromotor until F-1 day-just prior to fairing installation on Gantry 17A. The igniter shorting plug will only be removed when making the final connection of the igniter to the spacecraft harness. The spacecraft harness shorts the igniters when this connection is made.
- I. No electrical tests will be performed on the igniter in or near the motor assembly.
- J. The retromotor propellant autoignition temperatures are: 1 hour at 400°F or 8 hours at 300°F. The pyrogen temperature limits are -60°F to +190°F. The recommended continuous storage temperature is 80°F \pm 5°. All sources of excessive heat and shock and sources of flame or spark must be prohibited from the rocket motor and Pyrogen igniter assembly.
- K. The utmost care will be exercised in handling the retromotor and pyrogen to prevent mechanical damage and undue shock. The rocket motor will be lifted and moved only with a crane, hydroset, and its special hoisting adapter and only under the direct supervision of GSFC or Thiokol personnel.
- L. The motor may be rested in its special handling scallop or a heavily padded surface but will not be rested on any flat hard surface which might scratch, dent or overstress the case in a localized area.
- M. There will be no metal working on the rocket motor or pyrogen igniter or in their immediate vicinity.

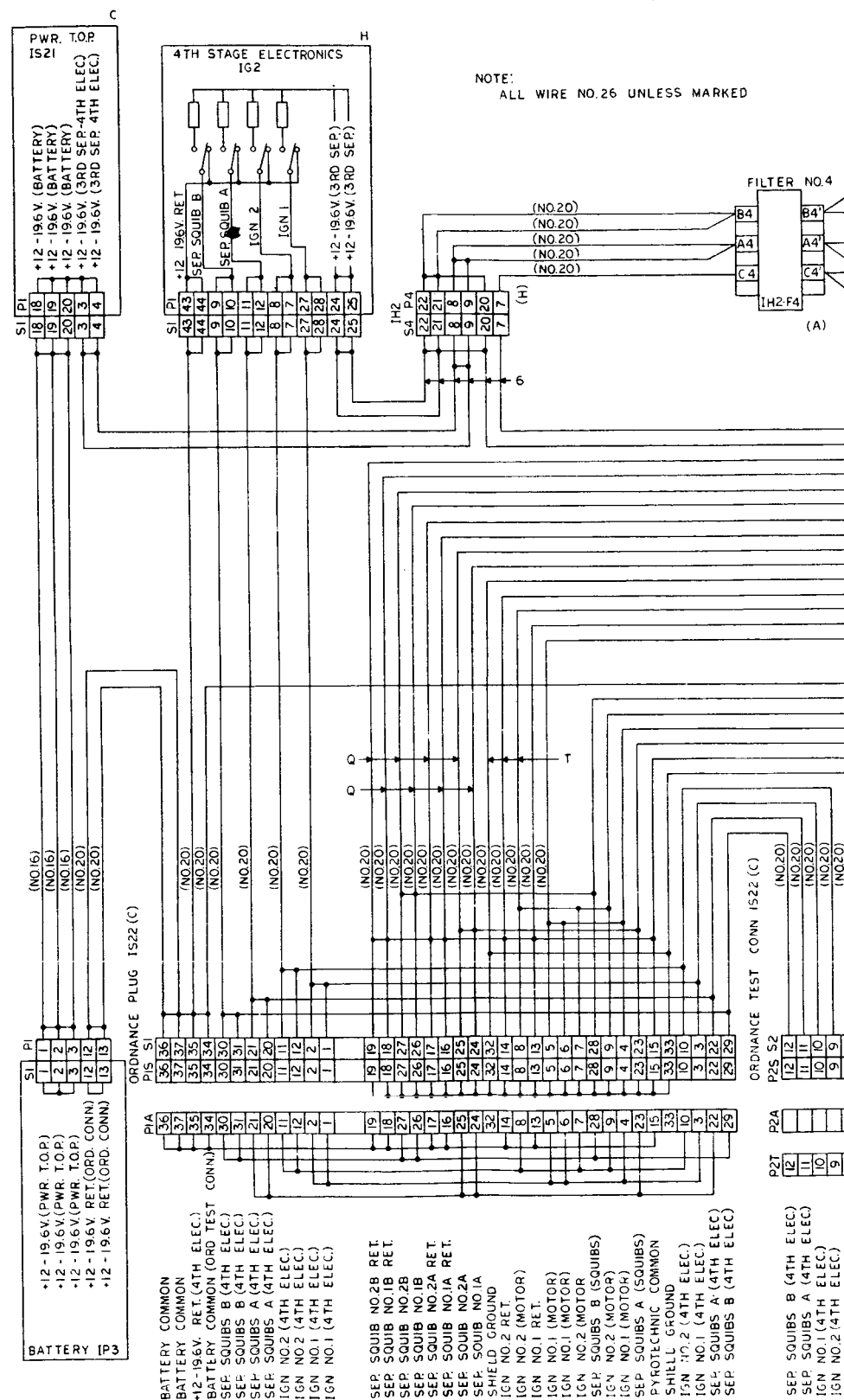
- N. The normal ordnance "common sense" practices will be enforced, i. e. , (a) no matches, lighters or other flame or high temperature producing devices within 50 feet of the motor and igniter (b) only approved spark-proof flashlights utilized within 50 feet (c) no smoking within 50 feet (d) no electric tools or electric machinery used on or near the rocket motor.
- O. Fire fighting equipment and emergency medical treatment will be available in retromotor assembly and storage areas.
- P. No static producing materials shall be utilized around the retromotor. Conductive (approved types) plastic will be utilized for clean room situations where necessary.

FIRING CIRCUIT DESCRIPTION

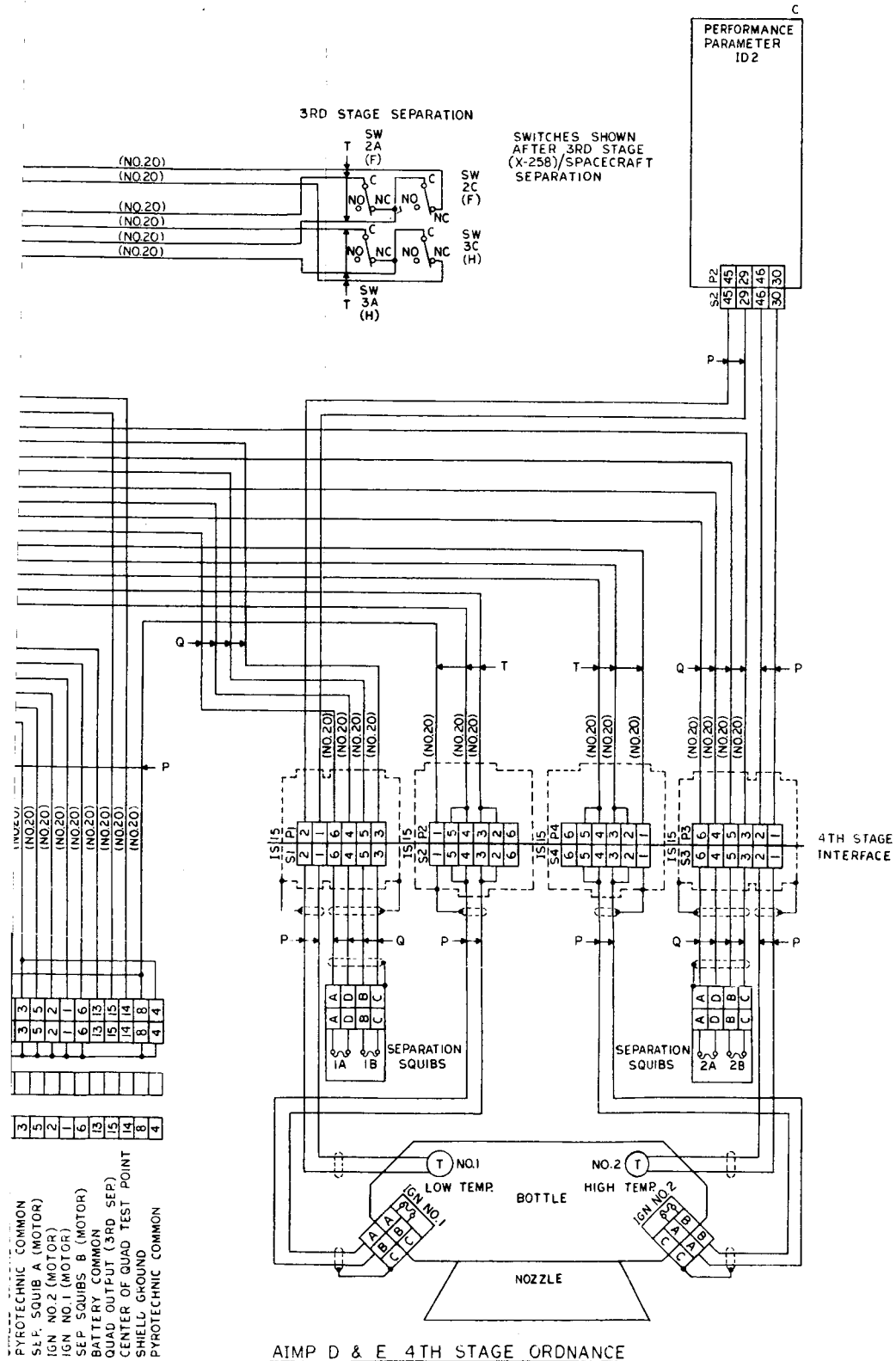
TE-M-458 retromotor firing signals are generated in the redundant 1G2 Fourth Stage Ignition and Separation Timer by satisfying a given set of conditions for the spacecraft and the associated ground equipment and following a systematic procedure. The 1G2 timer is controlled by external RF command via the on-board command decoders. (See schematic on following page for further details.)

The following conditions must exist on-board the AIMP Spacecraft in order for it to accept the externally generated RF "address tone" and three separate "execute tones" for either direct or 2 hour timed motor ignition:

- A. The spacecraft "live" turn on plug (IS21-P1 & P2) must be inserted. This plug connects the spacecraft batteries to the spacecraft — without it all power is disconnected.
- B. The spacecraft Ordnance Safe Plug (IS22-P1 SAFE) must be removed and the Ordnance Arm Plug (IS22-P1 ARM) inserted into the same connector.
- C. The ordnance safe test connector (IS22-P2 SAFE) must be removed and replaced by the ordnance arm test connector (IS22-P2 ARM). The short on the igniter remains until the firing relay of the 1G2 timer closes after receipt of appropriate RF command.
- D. The spacecraft must be separated from the third stage of the Delta vehicle in order for the 4 switches located on the 3rd stage interface (connected in a series parallel quad) to provide a closed path between the battery to the firing relay to the igniters.



NOTE:
ALL WIRE NO.26 UNLESS MARKED



During the motor inspection and assembly operations, in the NASA/DAC Spin Facility igniters will never be installed in the TE-M-458 retromotor. Neither will they be installed during the spacecraft electrical checks on Gantry 17A up to F-1 Day. After the F-1 Spacecraft electrical checks are complete, the two TE-P-462 Pyrogen igniters (with shorting plugs) will be assembled into the motor. A brief vacuum leak check will be made through the motor exit cone to insure proper seating of the pyrogen igniter "O" rings. The igniter shorting plugs will be removed and the spacecraft igniter harness connected to the igniters. During this operation all RF systems will be OFF and both Ordnance Safing Plugs will be inserted. The Delta fairing will then be assembled. After the F-O spacecraft checkout, the Two Ordnance Arming Plugs and the Turn On Plug will be assembled through the fairing access door.

ORDNANCE PREPARATIONS AND ASSEMBLY

The two retromotors and four igniters will be delivered to Cape Kennedy Air Force Station not less than six weeks prior to launch. Upon arrival the motors and igniters are to be placed in storage in the PAA Solid Propellant Storage area until NASA/GSFC and Thiokol personnel are notified and ready to inspect the units.

For any ordnance, inspection, preparation, or checkout the appropriate precautions listed under "General Safety and Handling Procedures" will be followed. See Preliminary Chart I for Motor Preparation Schedule.

Initially, the motors and igniters will be moved from storage to an area designated by the PAA Solid Propellants facility supervisor for inspection. The shipping containers will be inspected for any damage incurred during shipment. The motor shipping container will be opened for physical inspection of the motor, nozzle, nozzle post plug, spacecraft attach holes, etc. The initial igniter inspection includes a general physical inspection of the shorting plug, body, exit port, etc.

The igniters will be returned to their respective metal containers and taken to the Igniter Test Area for bridge wire resistance checks. This operation will be performed in the Igniter Test Area where personnel are protected by a steel and concrete barrier. A fit check will be performed using the spacecraft igniter harness (motor fiberglass adapter and harness assembly) and bridge wire resistance measurements made at the fly away spacecraft connector. The alinco Tester Model 101-5BFM will be utilized. Upon completion of the bridge wire resistance checks, the shorting plug will be reinstalled on the igniter. The shorted igniters remain in storage until F-1 day.

After the motor has been physically inspected a series of X-rays will be taken and analyzed to insure that no separations or cracks are evident in the grain configuration and that no discrepancies are detected in the nozzle or case. Thiokol personnel will be available with preshipment X-rays for comparison and consultation. After X-rays have been taken and analyzed, the motor will be placed on the fiberglass motor attach flange and appropriately grounded. The flight multilayered metallized thermal blanket will be fit checked on the retromotor. The retromotor thermal blanket consists of multilayered Kapton with vapor deposited aluminum on both sides. This blanket is slipped over the retromotor and fastened to the mounting flange of the retromotor with 16 stainless steel screws. The blanket, because of evaporated aluminum on both sides, is electrically conductive. It also will be continuously grounded during handling, assembly and after final assembly.

The motors and igniters are not required to follow a critically scheduled sequence but the operations must be completed in a timely manner in order that the motor (without igniters) is available for a fit and alignment check with the AIMP Spacecraft on F-14 days (working) at the NASA/DAC Spin Balance Area.

The retromotor, in its grounded shipping container, will be transported to the NASA/DAC facility approximately 14 working days prior to launch. A security escort will accompany the motor and the movement will be made during non-peak traffic hours as designated by Cape Safety.

After permission has been granted to proceed with operations and the area has been cleared of non-essential personnel, the shipping container cover is removed and the motor is lifted from the case using the air hoist and hydroset. Ground straps will be attached to the air hoist and motor case and will be connected to the building grounding system. Personnel will wear non-static producing, flame retardant coveralls and legstats.

Listed below is a running sequence of events which must be completed at the Spin Balance Area up through launch.

1. Weigh TE-M-458 Retro Motor (DAC & GSFC)
2. Weigh AIMP Spacecraft, Booms, and Paddles (DAC & GSFC)
3. Place spacecraft on magnetic deperm dolly and measure, deperm and measure again — place retro on S/C, deperm and measure again. (GSFC)

4. Place Retro Motor on precision measuring facility (PMF) (GSFC Supplied) and measure thrust vector (centroid of throat and exit cone) vs. geometric spin axis. (GSFC)
5. Remove Retro Motor from PMF and place spacecraft on PMF. Measure two precisely machined surfaces of thrust tube with dial indicator. Measure flatness of fiberglass motor mount. (GSFC)
6. Place Retro on Spacecraft on PMF. Align Retro Motor with dial indicator and calculate total thrust vector vs. C. G. misalignment. Bond two Retro Flight thermistors to motor case using DC 90-006 primer and aerospace sealant. Allow 12 hour cure. (GSFC)
7. Insert Dummy (inert loaded) igniters into Retro motor. Assemble retro thermal blanket using grounding clips. Blanket to be temporarily sealed at top to allow later assembly of igniters on F-1 day. (GSFC)
8. Move spacecraft-Retro combination onto third stage. Continuity check made from DAC attach fitting side thru yo-yo despin dimple motors using Alinco tester model 101-5BFM to insure proper mating of spacecraft/3rd stage yo-yo flyaway connector. (DAC & GSFC)
9. Assemble 4 solar paddles and two booms to spacecraft and assemble cord tie-down system. Adjust cord tension to 35 lbs minimum. (DAC & GSFC)
10. Dynamically balance Spacecraft-Retro motor-Delta 3rd stage assembly. (DAC)
11. Replace conductive asepsis bag over spacecraft. (GSFC)
12. Clean inside of DAC transport container with bath of isopropyl alcohol (chemically pure C^3H^7OH) prior to assembly over spacecraft/3rd stage/ spin table assembly. (DAC)
13. After container has been placed over spacecraft/3rd stage assembly, attach dry nitrogen purge system to container and activate. Container is continuously purged until unit is placed upon delta second stage. (DAC)
14. Spacecraft electrical turn on and checkout approximately F-5 thru F-1 on Gantry 17A. (GSFC)
15. F-2 day remove stripable coating from spacecraft, swab with isopropyl alcohol, take biological sample count. (GSFC)

16. F-1 Day

- a. Spacecraft electrical checkout including no-voltage check on spacecraft igniter harness connectors. Replace both safing ordnance connectors. (GSFC)
- b. Physically deactivate, remove and lock ground command stations in special area.
- c. Install live pyrogen igniter assemblies into Retro Motor. (GSFC and Thiokol)
- d. Lower plug into exit cone and run vacuum leak check to insure proper ignitor "O" ring sealing. (GSFC and Thiokol)
- e. Connect spacecraft harness to both igniters. (GSFC)
- f. Tape thermal blanket over igniters and around exit cone. (GSFC)
- g. Prepare spacecraft for fairing installation. This includes removing all experiment protective metal covers, physical inspection of hardware, etc. (GSFC)
- h. Take biological sample. (GSFC)
- i. Remove conductive asepsis bag from spacecraft. (GSFC)
- j. Fairing installation and spacecraft umbilical connection. (DAC)

17. F-O Day

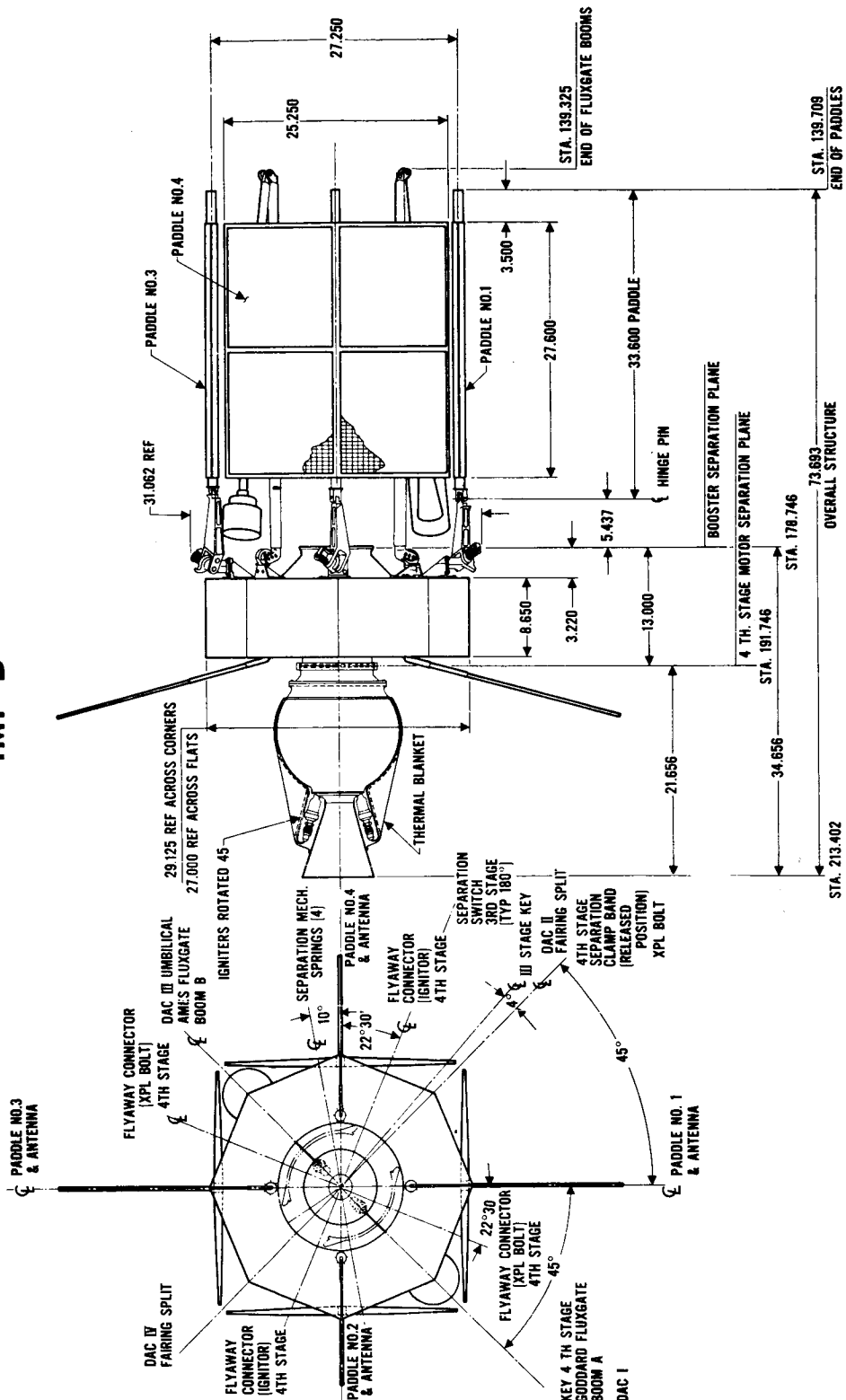
- a. Short-spacecraft checkout-electrical. (GSFC)
- b. Take last biological sample. (GSFC)
- c. Install turn on plug (IS21-P1 and P2 green). Install ordnance arm test connector (IS22-P2 green). Install ordnance arm plug (IS22-P1 green). Above installed thru fairing access hole. (GSFC)
- d. Fairing access ports sealed. (DAC)
- e. Gantry removal
- f. F-30 minutes spacecraft turn on from blockhouse.

SUMMARY

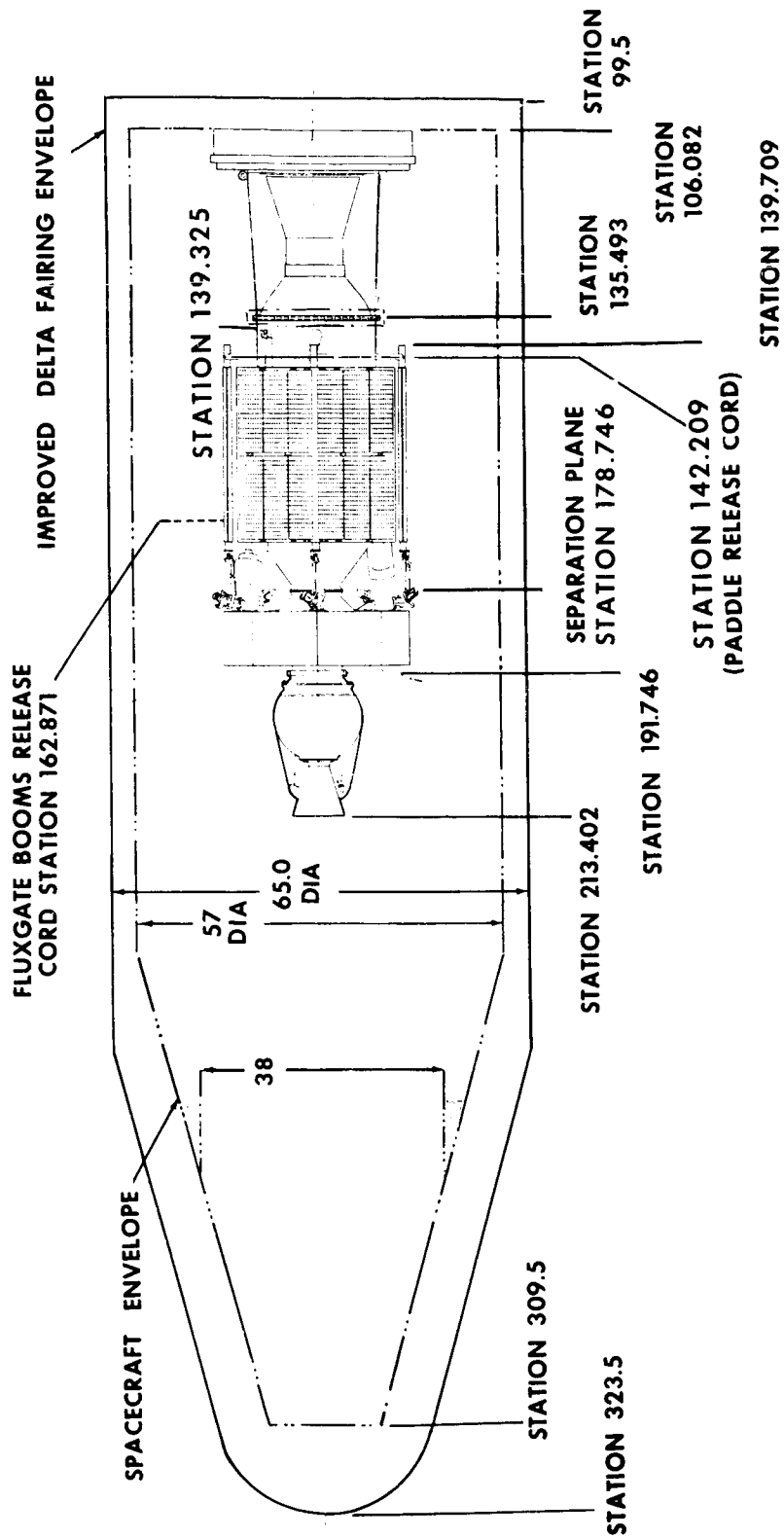
1. The igniter squibs will not fire with (a) current of one amp impressed on the squib for a period of 5 minutes or (b) power of one watt impressed on the squib for 5 minutes. The squibs will not fire from the two phase ZAP Test.
2. Igniter squibs have a minimum all fire current of 2.32 amps.
3. The Pyrogen igniters are not installed until just prior to Fairing installation on F-1 day. The igniters are shorted by the shorting plug directly on the igniters at this time.
4. Prior to connecting the harness from the spacecraft to the igniter on F-1 day, resistance and no voltage checks are made to ensure that all safety features are functioning.
5. Redundant mechanical switches interrupt the firing circuit until spacecraft separation from the third stage (X-258) approximately 20 minutes after liftoff.
6. The timer relay switches short the squibs to ground until receipt of the firing pulse.
7. Two separate non-flight squib shorting plugs (ordnance plugs) remain in place until just prior to sealing the fairing access port.
8. A spacecraft flight turn on plug is not inserted until just prior to sealing the fairing access port. This plug does not turn the spacecraft on but connects the spacecraft batteries to the spacecraft. Turn on is accomplished just prior to liftoff through the blockhouse umbilical.
9. All firing circuit wiring is twisted and shielded.
10. The connection of the spacecraft harness to the igniters will be made during a no-switching — no-radiation period on F-1 day.
11. During the igniter connection all non-essential personnel will be cleared from the area. The individual performing the operation will wear non-static producing coveralls, legstats and a wristat and make the connection while standing on a conductive mat connected to the vehicle grounding system.

12. A systematic procedure is required in order to generate a fire signal from the ground checkout equipment. This procedure will be under the direct supervision of the spacecraft Project Manager. All ground command station racks located in the electronic checkout consoles will be physically and electrically removed prior to Item 3 above. These individual command stations will be moved to hangar AE and remain in a locked area designated by the GSFC Project Manager. As noted in 5 above if a firing signal was generated after #7 and #8 above have been completed on F-1 day, it is isolated from the igniter squibs until the spacecraft separates from the 3rd stage X-258 approximately 20 minutes after liftoff.
13. The design philosophy, operational handling and safety precautions are similar or identical to those used on Syncom and Early Bird. The feature or capability of inserting the twin pyrogen igniters into the motor just prior to fairing installation on Gantry 17A on F-1 Day is an additional safety feature which was not possible on Syncom and Early Bird.

INTERPLANETARY MONITORING PLATFORM OUTLINE AND ORIENTATION IMP D



IMP "D" INSTALLATION



TE-M-458 RETRO MOTOR — PREPARATION SCHEDULE

Count-Down Days	17	16	15			14	13	12	11	10			9	8	7	6	5			4	3	2	1	0
Calendar Days	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1. Retro Motor Arrival →																								
2. Retro Motor Visual Inspection																								
3. Igniter Visual Inspection																								
4. Igniter Resistance and Fit Check with Fiberglass Adaptor																								
5. Retro Motor X-Rays																								
6. Retro Motor Fit Check with Thermal Blanket and F/G Adaptor																								
7. Motor without Igniters Delivered to Spin Balance Area																								
8. Motor Alignment																								
9. Mate Motor to Spacecraft with Inert Igniters and Align																								
10. Bond Retro Motor Thermistors and Thermal Blanket																								
11. Assemble and Spin Balance Retro Motor /Spacecraft/ 3rd Stage Assembly																								
12. Transport to Gantry 17A																								
13. Spacecraft Checks on 17A																								
14. Install Live Pyrogen Igniters																								
15. Run Retro Vacuum Leak Check																								
16. Motor Igniter Connection to Spacecraft Harness																								
17. Remove Igniter Safe Ordnance Plugs and Install Flight Ordnance Plugs																								
18. Launch																								